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RESEARCH ARTICLE

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Why We Cannot Resist Our Smartphones: Investigating Compulsive Use of Mobile SNS from a Stimulus-Response-Reinforcement Perspective

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Abstract

Compulsive smartphone use has attracted extensive social attention because of serious and even fatal outcomes associated with it. However, there has been little theory-driven research systematically investigating the mechanism of compulsive behavior in smartphone use. Although a significant line of literature exists in the area of personal-computer based technology addiction, the mechanism underpinning compulsive smartphone use differs significantly because the unique and specific characteristics of smartphones have given rise to a fundamentally different usage context with new usage behavioral patterns. In order to comprehensively theorize this issue, we first defined compulsive behavior in smartphone use, focusing on mobile social networking services (SNSs) in particular, and then extended the stimulus-response-reinforcement framework to investigate the theoretical network of compulsive use of mobile SNSs. We used online survey data from 368 active mobile SNS users in China to empirically test and validate the proposed model and hypotheses. Our results indicate that both positive and negative reinforcements, as well as the compensatory component, invoke the feeling of urge that leads to compulsive mobile SNS use. The positive effects of interactivity as an incentive stimulus on those reinforcements and compulsive mobile SNS use were also found to be significant.

Keywords: Compulsive Smartphone Use, Mobile SNS, Positive Reinforcement, Negative Reinforcement, Compensation Mechanism, Interactivity.

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1 Introduction

Representing the momentous evolution of information communication and technology, smartphones have produced new usage patterns of Internet use including information sharing, gaming, navigating, social networking, self-education, entertainment, and employing various applications (Salehan & Negahban, 2013). Because of their benefits to individuals and to society as a whole, smartphones have become extremely prevalent and have dramatically changed people's daily lives. For the majority of individuals, smartphone use is normal and routine. However, some users look at their smartphones' menu screens for news, emails, and social updates throughout the day. The failure to control an overwhelming impulse to compulsively check their smartphones pervades their lives and results in negative consequences. It is not surprising to find that smartphones have become the first thing many users reach for when waking up in the morning and the last thing they check before going to sleep at night (Perlow, 2012).

Anecdotal evidence confirms that compulsive smartphone use has proliferated among a large proportion of users and has even become an epidemic of sorts (Lee et al., 2014). Forty-six percent of American users report that they could not live without

their smartphones, and 15% of young adults are heavily dependent on smartphones (Smith, 2015). When being forced not to use smartphones, approximately 88% of professionals have a strong feeling of disorientation, anxiety, loneliness, and even physical illness (McCafferty, 2011). More seriously, it has been found that corporate executives are spending more and more time on smartphones in order to be connected 24/7 and are increasingly plagued by obsessive-compulsive disorders (Vijayaraghavan & Bhattacharyya, 2016). In line with this evidence, a set of symptoms has arisen, including phubbing (Krasnova et al., 2016), checking habits (Oulasvirta et al., 2012), the cycle of responsiveness (Perlow, 2012), smartphone addiction (Wu et al., 2013), and compulsive smartphone use (Wang, Lee, & Hua, 2014). Harmful and even fatal outcomes have been reported, including sleeplessness, stress, minimal human interaction, work interventions, and a general detrimental effect on mental health (Lee et al., 2014).

Despite extensive social concerns surrounding this issue, compulsive smartphone use has not drawn sufficient attention in information systems research and the scientific understanding of this problem is still evolving. The few existing studies on compulsive smartphone use have mainly focused on demographics and psychosocial characteristics, dimensions and measurement instruments, and diagnoses and treatment strategies (Lee et al., 2014; Park & Lee, 2011; Rosen et al., 2013). To date, there is scarce theoretical research exploring the development of compulsive behavior in smartphone use. One main reason might be that inconsistent nomenclature and conceptualization (e.g., the interchangeable use of addiction, compulsion, and habit) lead to a divergent theoretical basis for understanding compulsive behavior. From this perspective, we should primarily advance the understanding of this problem by exploring the similarities and differences between compulsive smartphone use and other behavioral addictions (Billieux, 2012).

Furthermore, although compulsive behavior has been typically perceived as a way to alleviate or compensate for tension, anxiety, or discomfort (American Psychiatric Association, 2000), the rational addiction assumption (Kwon et al., 2016) paves an alternative path to advancing our understanding of compulsive smartphone use. In the presence of high mobility and localization, multimedia capture and distribution, and instant connection and ubiquitous access (Pitt, Parent, Junglas, Chan, & Spyropoulou, 2011), the unambiguous advantages of smartphones have greatly shifted regular smartphone use toward the area of behavioral modification. The underlying mechanism in most compulsive behavior (i.e., compensation mechanism) thus may not be comprehensive enough to understand the ontological network of compulsive smartphone use. Instead, a systematic investigation on the underpinning mechanism of compulsive behavior occurring in smartphone use is necessary to gain insights and to provide support for effective management for both users and service providers.

More importantly, in spite of pervasive recognition of technological attributes increasing the potential to alter cognitive, affective, and behavioral paradigms of individuals (Ball-Rokeach & DeFleur, 1976), research has found that the majority of studies on compulsive behavior have not incorporated technological factors into their theoretical frameworks. In studies that have, technology is often nominally addressed (Davis, 2001; Wang, Lee, & Hua, 2015), such that technological attributes contribute and catalyze the developmental process of pathological use; in these studies technology is primarily in the background and not part of the core artifact of investigation. While general technological factors have been studied, there is a need to go beyond this to specify the distinct characteristics of smartphones and their role in stimulating individuals' compulsive behavior. As such, a careful contextualization is needed to further incorporate the technological factors into our theoretical framework.

Being motivated to theorize these issues, we attempt to answer the following questions: What accounts for the urge for compulsive smartphone use? If such compulsive behavior is causally related to smartphone-associated stimuli, what are these stimuli? To answer these questions, the current study establishes an extended theoretical framework seeking to clarify the development of compulsive smartphone use and compulsive mobile social networking service (SNS) use in particular. We first define compulsive behavior in the mobile SNS context and employ the stimulus-response-reinforcement framework to develop the theoretical model. We conjecture that both positive and negative reinforcement, as well as the compensatory component, invoke the urge to compulsively use mobile SNSs. We also identify interactivity as an incentive stimulus that influences users' compulsive behavior.

The rest of this paper is organized as follows. We first provide a summary of related literature and describe our research model and hypotheses. We then present the empirical research methodology and the results of the study. The paper concludes by discussing the implications of the findings for both theory and practice.

2 Literature Review

Given that the concept of compulsive smartphone use is relatively new in the literature, we initiate our discussion by situating it within previous compulsive behavior research. Then, we identify the specific characteristics of compulsive smartphone use, mobile SNSs in particular.

2.1 Compulsive Behavior

In previous research, a number of nomenclatures have been proposed to explain the dark side of usage behavior on smartphones, such as habit (Oulasvirta et al., 2012), dependence (Ahn & Jung, 2016), addiction (Salehan & Negahban, 2013; Wu et al., 2013), excessive use (Zheng & Lee, 2016), compulsive use (Lee et al., 2014; Park & Lee, 2011; Wang et al., 2014), and problematic use (Billieux, 2012). Although a growing consensus has been reached to view compulsive behavior as a behavioral manifestation of addiction and an aspect of problematic use (Xu, Turel, & Yuan, 2011), we believe that there are noteworthy features of compulsive behavior beyond the similarities it shares with these constructs (see Appendix A).

First, according to American Psychiatric Association, compulsive behavior refers to the performance of repetitive behavior aroused by obtrusive thoughts or obsessions (2000). Echoingly this point, O'Guinn and Faber (1989) state that most compulsive behavior is primarily identified as a type of chronic and repetitive behavior. Following such definitions, we believe that compulsive behavior describes uncontrollable behavioral repetitions that are characterized as chronic, irresistible, stimulus-orientation, and stereotyped (Caplan, 2002; Tiffany & Carter, 1998). Addiction, however, emphasizes more the psychological state of maladaptive dependency, and is typically accompanied by significant negative consequences (Turel, Serenko, & Giles, 2011). In contrast to the periodic repetition of compulsive behavior, addiction tends to be a continuing pattern (Hooper & Zhou, 2007) or continuum of unregulated behavior (LaRose, Lin, & Eastin, 2003).

Furthermore, compulsive behavior typically acts as a primary response to inner deficiencies, negative feelings, and events, thereby involving a compensation mechanism (Neuner, Raab, & Reisch, 2005). Consistent with this point, it has been recognized that compulsive behavior is performed due to the need to alleviate tension, anxiety, or discomfort (American Psychiatric Association, 2000). That is, to compensate for or relieve stress, disappointment, or frustration, people engage in compulsive behavior repetitively and excessively. As such, it is not surprising to find that compulsive behavior is motivated by individuals' attempts to adapt to stress rather than by simple exposure to the related activities or substances (Marlatt et al., 1988). Despite the significant role compensation mechanisms in explaining compulsive behavior, addiction behavior focuses more on maladaptive cognition based on the traditional cognition-behavior model (Turel, Serenko, & Giles, 2011; Wu et al., 2013).

More importantly, although both habit and compulsive behavior are performed in an effortless and a nonreflective way, habit is merely the routinization of behavior in certain situations to achieve efficiency (Limayem, Hirt, & Cheung, 2007), whereas compulsive behavior tends to be unintentional or uncontrolled (Tiffany & Carter, 1998). Habit is widely recognized to be activated by satisfaction, stable context, the frequency of prior behavior, and comprehensiveness of use (Limayem et al., 2007); however, it may have undesirable outcome consequences, including unregulated usage (LaRose et al., 2003) and psychological dependence (Wang, Lee, et al., 2015). In contrast, compulsive behavior may be associated with far more severe consequences, including debilitating or disrupting individuals' abilities to function; it even becomes destructive if left untreated (American Psychiatric Association, 2000).

To summarize, we believe that compulsive behavior is different from addiction and habit and that identifying such differences (e.g., periodical and uncontrollable behavioral repetition with a compensatory component) is helpful and effective for understanding its underlying mechanism. We thus use compulsive behavior to represent behavioral patterns that are performed repetitively, stereotypically, and uncontrollably. Based on the previous definitions, we define compulsive smartphone use as a repetitive, ritualistic behavior involving an individual's inability to control, reduce, or stop smartphone use (Caplan, 2002; Meerkerk et al., 2010).

2.2 Compulsive Smartphone Use

The majority of literature on this topic has investigated individuals' compulsive behavior regarding the Internet or smartphones as a whole, rather than focusing on a specific application (Lee et al., 2014; Wang et al., 2014). Nevertheless, it has been suggested that specific pathological Internet use indicates a particular purpose, whereas generalized pathological Internet use refers to a more global set of behaviors (Davis, 2001). Echoing this, scholars have found that social networking, chatting, blogging, and online gaming exert stronger effects on compulsive Internet use as compared to other Internet technologies (Van Rooij et al., 2010). Likewise, cross-sectional chatting and gaming have also been shown to have the strongest correlations with compulsive Internet use (Meerkerk et al., 2010). Hence, social networking, social media, and online gaming are proposed as the most important real-time interactive applications, and their usage cannot be directly substituted by other Internet or smartphone applications (Wang, Lee, et al., 2015; Xu et al., 2011). Based on this, we believe that specific application, rather than general smartphone use, is more

appropriate for describing and capturing individuals' compulsive smartphone use.

Compulsive use of mobile SNSs (e.g., Facebook, Twitter, WeChat) is thus of particular importance in the current study. Although the other smartphone applications cannot be wholly disregarded, mobile SNSs are unique in that they highly facilitate social connection and instant communication, which, for many, is the most important aspect of smartphone use (Pitt et al., 2011). Echoing this point, the capacity for socialization and real-time interactions has been identified as a primary reason for the excessive amount of time people spend using smartphones (Byun et al., 2009). Correspondingly, SNS use is evidenced as a significant and strong predictor of smartphone addiction, even as compared to game use (Griffiths, 2010; Salehan & Negahban, 2013). Hence, we assume that mobile SNSs represent the main usage context for compulsive smartphone use. Compulsive use of mobile SNSs thus refers to a repetitive, ritualistic behavior involving an individual's inability to control, reduce, or stop the use of mobile SNSs.

2.3 Compulsive Use of Mobile SNSs

A review of prior literature found that compulsive behaviors occur in various domains, such as buying, using cocaine, Internet use, and smartphone use (Meerkerk et al., 2010; Wang et al., 2014). Despite the common characteristics of compulsive behavior, we believe that the specific behavioral characteristics of compulsive mobile SNS use should be investigated to move the theoretical understanding forward. Accordingly, research has highlighted that understanding behavioral characteristics is useful and effective for capturing usage behavior and its motivation (Hooper & Zhou, 2007).

Research postulates that compulsive use of mobile SNSs functions as a seemingly "rational" and "voluntary" choice (Kwon et al., 2016; Wang et al., 2014). Given that mobile devices allow individuals to apprise themselves of the latest news and updates in a greater variety of contexts and situations, as compared to the stationary web, smartphones are widely used by individuals to make use of spare time (Malinen & Ojala, 2012; Park & Lee, 2011). From this perspective, individuals compulsively use their mobile SNS mainly to maximize perceived rewards (e.g., information, connection, and entertainment) (Wang, Lee, et al., 2015). Previous literature also recognizes that satisfaction and perceived enjoyment positively influence compulsive smartphone use (Park & Lee, 2011). Hence, to pursue desired benefits and rewards, compulsive use of mobile SNS seems to be repetitively performed in a normal, reasonable, and socially acceptable way (Hooper & Zhou, 2007).

Meanwhile, compulsive mobile SNS use is performed in a stereotypic and even compulsory manner to avoid and escape negative feelings. In such cases, individuals defensively approach the use of mobile SNSs to overcome potential conflicts associated with nonuse behavior and to relieve the feeling of missing out, anxiety, and withdrawal (Rosen et al., 2013; Wang, Lee, et al., 2015). In other words, the use of mobile SNSs may become a necessary part of daily life (Lee et al., 2014). If such stereotyped usage is omitted or terminated, an increased probability of following checking behavior will occur (Everitt & Robbins, 2005). Therefore, compulsive use of mobile SNS may be developed because of the avoidance of punishment experiences as well as the pursuit of desired rewards.

3 Theoretical Background and Research Hypotheses

Although compulsive behavior is traditionally perceived as a behavioral response to inner deficiencies and negative feelings, we advance our understanding of compulsive mobile SNS use by illuminating the role of reward and punishment experiences. Given this theoretical recognition, we further extend the stimulus-response-reinforcement framework to the mobile SNS context in order to clarify the underlying network and enacting variables of compulsive behavior.

3.1 Stimulus-Response-Reinforcement Framework

The stimulus-response-reinforcement framework (SRR) was first introduced by Hull (1943) to describe the principle of individual behavior and was then widely used to explain the associations between active sensory and motor processes that are reinforced and strengthened by rewarding events (Balleine, 2005). The basic rationale of SRR is that the response will be reinforced upon sequential presentation of the same stimulus (Belleville, 1964). In the presence of the stimulus, the response "occurs most frequently when these conditions are repeated," and may even become compulsive, without any consideration of the potentially extreme negative consequences associated with such behavior (Belleville, 1964, p. 95).

To be more specific, stimuli include situational stimuli and incentive stimuli, and certain situational stimuli will turn into conditioned or unconditioned incentive stimuli to generate central motivational states, which further influence the potency of the response (Bindra, 1974). Acting as a procedure (i.e., delivering a reinforcer) or a process (i.e., strengthening the likelihood of the reinforced response repetitively in the same or a similar situation), reinforcement promotes the consolidation of sensory-motor

association and functions as the mediation of stimulus and response (Sagvolden et al., 2005). In other words, the relationship between specific stimuli and action is formed and sensitive to the reinforcement of the stimuli. Reinforcement is thus defined as "the tendency of certain stimuli to strengthen learned stimuli-response tendencies" (White, 1989, p. 181). Consistently, it has been suggested that incentive stimuli likely elicit a particular type of reinforcement, increase the frequency of associated response, and establish the link between that type of reinforcement and response (Michael, 1982).

According to SRR, reinforcement is highlighted as "the core behavior-shaping mechanism" (Tittle, Antonaccio, & Botchkovar, 2012, p. 864). It is important to note that reinforcers include not only positive reinforcements but also negative reinforcements. On the one hand, a stimulus associated with positive reinforcement has a motivational effect on the subsequent behavior. Such positive reinforcement might include entertainment, attention, and positive feedback from past behaviors (Achab et al., 2011). Through the reduction of drive, positive reinforcement could be perceived as a rewarding experience that strengthens the tendency of elicited behavior (Balleine, 2005). Hence, to achieve the reward value that provides internal reinforcement, the propensity to perform the response is high. On the other hand, the reward unit in the incentive system delivers a reinforcement signal to the habitual and even compulsive pattern (Balleine, 2005). If the action is curbed, the habitual usage pattern might negatively reinforce the link between the stimuli and response to avoid negative consequences (Achab et al., 2011). Under this condition, it is believed that negative reinforcements exert an important role in sparking the response. Therefore, it has been proposed that both positive (e.g., rewards or good consequences) and negative (e.g., lack or removal of punishments) reinforcements are associated with a strong desire to act and increase the likelihood of repeating a particular action (Akers et al., 1979).

Rather than adopting a theory that has been widely used in previous research, such as social cognitive theory (Turel, Serenko, & Bontis, 2011; Wu et al., 2013), the functionalist perspective (Xu et al., 2011), cognitive-affective-behavioral model (Wang, Lee, et al., 2015), or an extended technology acceptance model (Turel, Serenko, & Giles, 2011), we adopt SRR as a prominent theoretical framework to explain compulsive mobile SNS use based on two critical reasons. First, SRR has been characterized as both a habitual (i.e., the automatic and stereotype process) and goal-directed learning process (i.e., the pursuit and maximization of the rewards) (Balleine, 2005, p. 718). A key assumption of SRR is that when individuals encounter stimuli, the rewarding experiences reinforce the occurrence of the subsequent response in a habitual and even compulsive way (Belleville, 1964). Consistently, it is assumed that compulsive smartphone users compulsively pursue such reward-directed experiences (Malinen & Ojala, 2012; Park & Lee, 2011). Thus, SRR represents a more systematic foundation in understanding the compulsive use of mobile SNS. Second, according to SRR, the link between stimulus and response is based on repetition and strengthened by specific reinforcements. Consistent with this point, research has indicated that compulsive behavior is performed as stimulus-orientation and periodic repetition, whereas addiction is a continuum of unregulated behavior with excessive dependency (Hooper & Zhou, 2007; LaRose et al., 2003). From this perspective, SRR might be more appropriate for understanding the uncontrollable repetition of compulsive mobile SNS use.

3.2 The Role of Urge

According to the SRR paradigm, it is further assumed that compulsive use of mobile SNS is driven and elicited by the feeling of urge. Typically, compulsive behavior is a spontaneous action without much reflection (Tiffany & Carter, 1998). Such spontaneity of impulse-control disorder (i.e., obsessive thought or obsession) is always reflected by an irresistible urge or state (Grant, Brewer, & Potenza, 2006) that is characterized as an inability to resist the impulse to continue the behavior.

Being sparked at a specific time and place, the feeling of urge is activated with little deliberation or evaluation of consequence (Beatty & Elizabeth Ferrell, 1998). Urge thus refers to the strong, sudden, and irresistible motivational state of an individual's intent to engage in particular behavior (Beatty & Elizabeth Ferrell, 1998). In alignment with this definition, we define the urge of an individual's compulsive checking behavior as a state of a sudden, strong, and irresistible desire to use one's mobile SNS.

Urge, involving a need, want, or desire, has been well-recognized as an important factor in the maintenance of problematic behavior. Research has proposed that this impulsive and urgent feeling may be the strongest predictor of compulsive technology use (Meerkerk et al., 2010). From this perspective, urge always precedes actual action. That is, the appetitive urge, impulse, and drive experience are felt prior to the performance of the problematic behavior (American Psychiatric Association, 2000). More importantly, subsequent urges are acted upon more quickly than previous urges (Beatty & Elizabeth Ferrell, 1998). Therefore, it can be concluded that the likelihood of engaging in problematic behavior increases when the individual experiences high levels of urge.

Extending this point into the context of mobile SNSs use, the threshold for crossing over from urge to action (e.g., browsing, sharing, and commenting via mobile SNSs) is greatly reduced with the growing pervasiveness of mobile devices. Given the high mobility, instant connection, and ubiquitous access of smartphones (Pitt et al., 2011), users are more vulnerable to checking their mobile SNSs when they experience a strong urge to obtain information or to instantly connect with their friends and families. Hence, we believe that the feeling of urge increases the likelihood of compulsive use of mobile SNS.

H1: The feeling of urge is positively associated with compulsive mobile SNS use.

Again, it is noteworthy that urges will be stimulated and related behavior will be activated in the presence of cue-induced situations (Ko et al., 2009). Consistent with this point, previous literature has suggested that considerable stimuli induce urges through a variety of mechanisms (Raylu & Oei, 2004). For example, affect (i.e., a set of emotional and high-level sensory feelings) has been identified as a significant determination in the stimulation and reinforcement of compulsive behavior (Baker et al., 2004). When people feel positive affect in response to an act, they are more likely to feel the urge to repeat it (Beatty & Elizabeth Ferrell, 1998). However, the probability that individuals will repeatedly use their smartphone also increases in response to feelings of negative affect (Wang et al., 2014). Following this line of reasoning, we incorporate both positive and negative affect in capturing the antecedents of urge to compulsive use of mobile SNS (as shown in Figure 1).

3.3 The Role of Positive Reinforcements

According to SRR, positive reinforcers describe the procedures or processes that increase the probability of a response (Everitt & Robbins, 2005). In this study, we use positive affect and gratification to represent the positive reinforcers that increase individuals' urges to compulsively check their mobile SNSs.

Positive affect is defined as the degree to which individuals feel enthusiastic, active, and excited (Verhagen & van Dolen, 2011). According to Beatty and Elizabeth Ferrell (1998), individuals are more likely to feel the urge to repeat an act when they feel positive affect in response to the act. One possible explanation of this link is that positive affect reflects "a state of high energy, full concentration, and pleasant engagement" (Beatty & Elizabeth Ferrell, 1998, p. 172). Therefore, individuals are more prone to engage in approach behavior rather than avoidance behavior when they experience positive affect.

Importantly, positive affect is identified as a crucial predictor in urges to behave irrationally (Beatty & Elizabeth Ferrell, 1998; Verhagen & van Dolen, 2011). In some extreme cases, the desire to maintain the positive affect is so strong that addiction-like symptoms develop (Chou & Hsiao, 2000). Previous studies have also found that the ability to produce a positive affective state is the crucial appetitive motivation maintaining compulsive drug use (Stewart, De Wit, & Eikelboom, 1984). We thus suspect that individuals may experience immediate and compulsively urges to engage with their SNSs to pursue and maintain a feeling of positive affect. Hence, we postulate that:

H2: Positive affect related to mobile SNS use is positively associated with the feeling of urge.

It has been widely recognized that compulsive behavior may develop because of the ready availability of easy short-term rewards (Young & de Abreu, 2010). The immediate reward experience can be reflected by the gratification of individuals' various needs, such as information seeking, relationship maintenance, and virtual community (Song et al., 2004). As the capabilities of mobile SNS become more sophisticated and multifunctional, a number of gratifications have been identified in the context of mobile SNS use, including social engagement, empathy, community interest, reciprocity, and reputation (Oh & Syn, 2015).

The hypersensitivity of reward systems to activation gives rise to greater intentions, expectations, and desires (Hiroi & Scott, 2009). Therefore, when gratifications are obtained, people feel satisfied and are more likely to continue using a particular medium (Song et al., 2004). Such active consideration of gratification expectations would also motivate individuals to dysregulate intentional usage because of the positive affect caused by the usage behavior (LaRose et al., 2003). Instant gratification thus positively links to positive affect (Song et al., 2004); likewise, research has demonstrated that the degree of gratification of addicts is significantly higher than that of nonaddicts (Yang & Tung, 2007). Hence, we hypothesize that:

H3: The gratification from mobile SNS use is positively associated with positive affect related to its use.

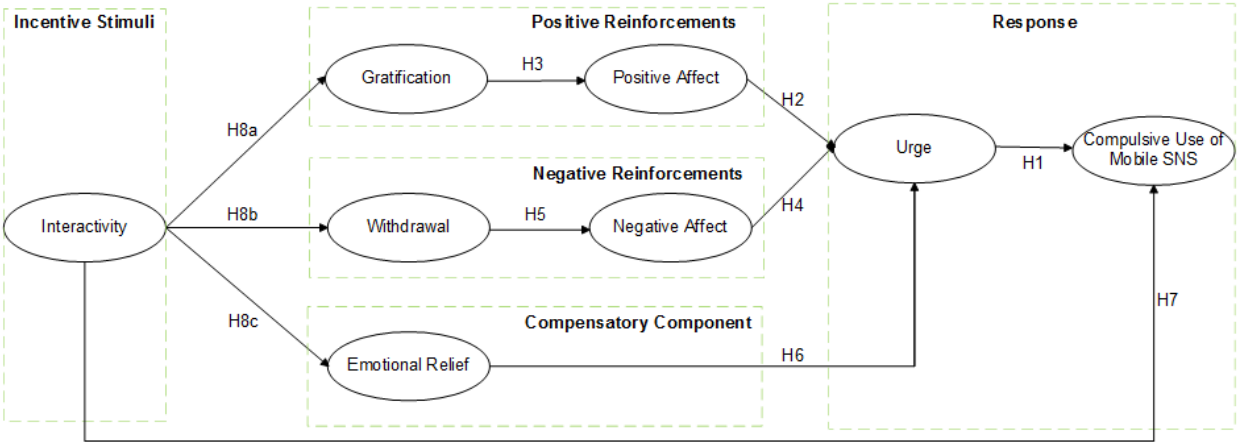

Figure 1. Research Model

3.4 The Role of Negative Reinforcements

Negative reinforcers can be defined as the increased probability of a response when an action is omitted or terminated (Everitt & Robbins, 2005). As a type of negative reinforcer, negative affect involves a feeling of distress and nonpleasurable engagement, such as distress, upset, and irritability (Beatty & Elizabeth Ferrell, 1998). The signal and reinforcement of the negative affect, in turn, are more likely to lead to the development of compulsive behavior (Baker et al., 2004). In line with this point, it has been found that anxiety resulting from not checking one's smartphone is positively associated with the clinical symptoms of psychiatric disorders (Rosen et al., 2013). Similarly, when being forced to not to use smartphones, individuals can experience a high level of upset and irritability (Wang, Lee, et al., 2015). From this perspective, we postulate that the felt urge will increase when a user experiences the negative affect of the nonuse of his/her mobile SNS.

H4: Negative affect related to the nonuse of mobile SNS is positively associated with the feeling of urge.

Withdrawal occurs when a compulsive activity is suddenly reduced or discontinued; this involves a heightened state of psychological and physiological arousal and discomfort (Baker et al., 2004). Such unpleasant feelings create negative affect if a person cannot engage in the related behavior (Turel, Serenko, & Giles, 2011). From this perspective, research suggests that compulsive behavior can develop as a means of escaping from or avoiding withdrawal symptoms (Baker et al., 2004).

Extending this point into the current context, Young and de Abreu (2010) have found that many young people feel "deeply upset" if they miss phone calls or mobile messages. People cannot tolerate the idea of the loss of smartphones and even sleep with their smartphones—smartphone use allows individuals to be connected 24/7 (Perlow, 2012). More seriously, without the use of mobile SNS, individuals may feel lost, wonder what is happening, and may find it hard to stop thinking about what is waiting for them on their smartphones (Wang, Lee, et al., 2015). The feeling of missing out promotes individuals' regular mobile SNS checking behavior and they may even develop obsessive thoughts if they are not receiving notifications (e.g., Facebook or Twitter alerts). Hence, we hypothesize that:

H5: Withdrawal symptoms from the nonuse of mobile SNS are positively associated with negative affect.

3.5 The Role of Compensatory Component

Again, according to the clinical psychology literature (Hogarth & Chase, 2011), compulsive behavior is performed because of the need to alleviate discomfort or negative feelings (e.g., sadness, loneliness, and depression). Neuner et al. (2005) propose that compulsive behavior acts as a primary response to inner deficiencies, negative feelings, and events. To compensate or relieve feelings of stress, disappointment, and frustration, people engage in compulsive behavior repetitively and excessively. This tendency to use this behavior to relieve negative emotions aligns with the compensation mechanism of compulsive behavior. As such, research suggests that emotional relief, referring to "an individual using the technology in order to facilitate some changes in negative affective states" (e.g., talking with and contacting others when feeling isolated or down) (Caplan, 2002, p. 563), acts as the predominant motive for compulsive behavior (Baker et al., 2004).

Similarly, the irresistible urge to perform or repeat a behavior emerges from the need to regulate one's

negative emotions (Soutullo, McElroy, & Goldsmith, 1998). The feeling of arousal leading to the performance of compulsive behavior is thus experienced as a quick access to relief (American Psychiatric Association, 2000). In other words, dysphoric mood states induce compulsive behavior as a conditioned escape response.

H6: Emotional relief is positively associated with the feeling of urge for compulsive mobile SNS use.

3.6 Interactivity as Incentive Stimulus

Based on SRR, incentive stimuli elicit approach behavior. In the presence of such stimuli, the response is reinforced according to some schedule of reinforcement (Everitt & Robbins, 2005). Specifically, in substance-based addictions, incentive stimuli are psychoactive substances that invoke an internal reward system (Loonis, Apter, & Sztulman, 2000). For instance, proponent-process theory has convincingly proposed that drug-related stimuli can spark "drug-like" effects to motivate further drug-taking behavior (Stewart et al., 1984). In behavior-based compulsion, incentive stimuli take various forms depending on the nature of the behavior.

To specify the stimuli that elicit problematic Internet use, Davis (2001) proposes that "the sound of a computer connecting with an online service, the tactile sensation of typing on a keyboard, and even the odor of one's office or primary place of using the Internet" result in conditioned response (p. 191). However, it has demonstrated that simple exposure to the related activities/substances might not act as the primary motivation of compulsive behavior (Marlatt et al., 1988). In addition, Davis's general discussion does not specify the distinct characteristics of the technology and their role in stimulating individuals' compulsive behavior. As such, we argue that the specific technological attributes of mobile SNSs (interactivity in particular) act as incentive stimuli that strengthen and reinforce the development of compulsive behavior.

Interactivity is defined as a critical function that facilitates users' timely communication and increases perceptions of social value (Zhao & Lu, 2012). More specifically, interactivity covers "two-way communication, interpersonal interaction, and reciprocal communication between two or more people" (Yoo, 2011, p. 70). In this regard, mobile SNSs support a powerful platform allowing users to share thoughts and communicate with others through functions of interaction including chatting, commenting, replying, forwarding, and liking. The high level of interaction in mobile SNSs produces great value for users, positive attitudes, and satisfaction (Zhao & Lu, 2012); thus, it is likely to be strongly desired and may even drive obsessive-compulsive behavior (James et al., 2017).

Consistently, previous studies have found that inherent interactivity transforms Internet applications into important social tools and leads to addiction (Chou & Hsiao, 2000). Individuals' online experience of interaction has also been demonstrated to be an antecedent of problematic behavior in SNS use (Huang, Hsieh, & Wu, 2014). In relation to this point, attaining interpersonal goals is identified as the primary motivation for compulsive behavior (Hooper & Zhou, 2007). To receive desired responses, positive interactivity derived from online activity may drive individuals' excessive usage behavior in reverse (Davis, 2001). Social motives (as well as the symbolic meaning of both the object and the behavior) have also been proposed as an important and effective factor for understanding compulsive behavior (Orford, 2001). Following this line of reasoning, we can assume that a high level of interactivity exerts a positive effect on the performance of compulsive behavior. Therefore, we hypothesize that individuals who experience a high level of interactivity in mobile SNS use are more likely to engage in compulsive behavior.

H7: Interactivity is positively associated with compulsive use of mobile SNS.

3.6.1 The Relationship Between Interactivity and Gratification

Previous literature has shown that positive affective states are invoked by environments featuring certain substances (e.g., drugs) or behavior (Stewart et al., 1984). For instance, drug-associated stimuli invoke "conditioned pleasure," thereby motivating individuals to subsequently seek the drug (Robinson & Berridge, 1993). Analogously, mobile technologies are potentially psychoactive because they offer and trigger enjoyable feelings (Oulasvirta et al., 2012). A high level of interactivity experienced on mobile SNSs allows users to instantly connect and interact with others—for example, by sending and receiving information, engaging in video calls, updating status, and so forth (Hooper & Zhou, 2007). The ability to instantly acquire accessible rewards (e.g., companionship, communication, and connection) through interaction thus functions as a positive stimulus for users, causing them to seek continued use (Stafford, Stafford, & Schkade, 2004).

Research has suggested that greater use of interactive features provides individuals with more opportunities to meet needs, higher amounts of satisfaction, and greater psychological affinity (MacInnis & Jaworski, 1989; Zhao & Lu, 2012). Thus, an increased level of interactivity presumably leads to favorable attitudes and evaluations; likewise, research in the context of online newspapers has found that interactivity had

positive effects on gratification (Yoo, 2011). Consequently, we assume that interactivity creates instant gratification deriving from the mobile SNS use.

H8a: Interactivity is positively associated with gratification deriving from mobile SNS use.

3.6.2 The Relationship Between Interactivity and Withdrawal

From the negative reinforcement viewpoint, compulsive behavior is sustained and reinforced because of the alleviation of aversive states (e.g., withdrawal) (Wise & Bozarth, 1987). The conditioned withdrawal, in turn, is elicited when people are exposed to environmental stimuli previously associated with compulsive behavior (Robinson & Berridge, 1993). In other words, we anticipate that the presence of incentive stimuli (e.g., interactivity) invokes the occurrence of withdrawal symptoms.

In the context of mobile SNS, a high level of interactivity allows users to communicate with others, develop their presence, maintain established networks, and build new online connections (Lin, Fan, & Chau, 2014). The convenience of connecting and interacting with others almost anywhere at any time, however, makes people more vulnerable to experiencing withdrawal symptoms (i.e., feelings of restlessness, irritability, and agitation) if they cease the relevant checking activity. Reinforcement sensitivity theory also proposes that the termination of rewards is likely to invoke feelings of negative affect and withdrawal behavior (Meerkerk et al., 2010). For instance, people preoccupied with the use of mobile SNSs to connect with others may wonder what is happening and may find it hard to stop thinking about what may be waiting for them on their smartphones if deprived of use (Caplan, 2002; Wang, Lee, et al., 2015). Similarly, scholars have highlighted that when users cannot obtain the expected interactivity from smartphones, they are more likely to experience anxiety and perform compulsive behavior (Wang et al., 2014). Therefore, we assume that individuals who perceive a high level of interactivity while using mobile SNSs will be more likely to experience withdrawal symptoms.

H8b: Interactivity is positively associated with withdrawal deriving from mobile SNS use.

3.6.3 The Relationship Between Interactivity and Emotional Relief

Emotional relief describes those experiences that "users engage with to change internal emotional states" (Rui, 2010, p. 13). Compensation mechanisms of compulsive behavior cause individuals to behave compulsively to relieve stress and negative emotions (Hooper & Zhou, 2007; O'Guinn & Faber, 1989). If such attempts are initially successful, compulsive behavior will be reinforced (Hanley & Wilhelm, 1992).

Smartphones, and mobile SNSs in particular, provide an easy and immediate way to obtain relief from feelings of depression, social exclusion, and boredom. For instance, a person can easily access and interact with other users to relieve boredom. As individuals experience emotional changes through interacting and connecting with others, they may be more vulnerable to and psychologically dependent on the technology, which may then spark urges in usage behavior (Turel, Serenko, & Giles, 2011). Consistent with this point, previous studies have found that social values and communication benefits yielded from interactivity cause users to experience emotional changes and promote usage behavior in the context of social media (Wang, Jin, et al., 2015). This point also holds true in the use of video games, such that relief is readily elicited in the experience of social interaction between users (Rui, 2010). The effect of social interaction on emotional relief has also been highlighted in disaster situations—the active use of social communication through SNSs relieves emotional distress (Neubaum et al., 2014). Hence, we postulate that:

H8c: Interactivity is positively associated with emotional relief deriving from mobile SNS use.

3.7 Controlled Effects

Our study incorporates a number of controlled variables, including respondents' demographics (e.g., age, gender, education, income, and employment) and usage experience with mobile SNSs. This is important because demographic variables and usage experiences have been shown to be important moderating variables in IS usage studies (Venkatesh et al. 2003).

4 Research Methodology

4.1 Measurement

We adapted established measurements from previous studies to measure most constructs in our research model, modifying the wording to fit the mobile SNS context. Items were measured on a 7-point Likert scale, with anchors ranging from *strongly disagree* to *strongly agree*. Appendix B lists the measurement instruments for each construct.

Importantly, it should be noted that we use a single dimension to operationalize the compulsive use of mobile SNS. Compared with previous studies that operationalize compulsive behavior as a multiple-dimension construct, we believe that a concise definition that focuses on the compulsive behavior itself, rather than its antecedents and consequences (e.g., preoccupation, withdrawal symptoms, coping, and conflict with regard to the usage behavior), is more appropriate to conceptualize compulsive smartphone

use. Furthermore, the one-dimensionality of compulsive use suggests a more unequivocal starting point and theoretical framing for understanding the underlying mechanism of compulsive use (Meerkerk et al., 2010). Following this line of reasoning, we refer to the definition of compulsive use of mobile SNS given above and adapt measurement scales on the basis of previous studies (Caplan, 2002; Meerkerk et al., 2010).

4.2 Data Collection

An online survey method is one of the most commonly used approaches in prior studies on compulsive behavior (Meerkerk et al., 2010; Wang et al., 2014). Prior to the data collection, we invited 56 active mobile SNS users to participate in a pilot study to refine the clarity of instructions and questions in the online questionnaire. The pilot study proceeded without any problem, which evidenced that the measurement was appropriate and the questionnaire was understandable and operational.

In the full-scale field study, we posted our invitations in various popular mobile SNSs in China (e.g., WeChat, Mobile QQ, and Sina Microblog) to recruit active users to complete an online questionnaire. However, we only asked respondents to report their WeChat usage experience in the questionnaire, since WeChat is the most popular mobile SNS application in China and has 980 million monthly active users (Tencent, 2017). More importantly, this allowed us to control technological features and avoid potential perception differences existing among different mobile SNSs.

To encourage participation in our full-scale study, we used a lottery incentive to encourage more participation. We ended data collection when no new responses were generated. A random sample of 468 potential respondents expressed their initial interest in the study and examined the study's information online. Of these respondents, 69 did not complete all survey items and were dropped, leaving 399 responses. Because of the length of the survey, and to decrease monomethod bias, we followed the best practice of using two attention-trap questions to determine if the respondents had read all the questions fully and answered honestly (Lowry et al., 2013). We excluded the data of 31 respondents because they failed at least one of two randomized attention-trap questions. This left us with 368 valid responses, including 230 men (62.50%) and 138 women (37.50%). The majority of respondents (89.13%) were between 18 and 30 years old. In addition, 90.76% of users had used mobile SNSs for more than one year. On average, 77.44% of users checked their mobile SNSs several times a day. The detailed demographics of the respondents are shown in Appendix C.

5 Data Analysis

We estimated the research model using the covariance-based SEM (CB-SEM) tool STATA (version STATA/SE 14.2). We adopted CB-SEM instead of some alternative techniques such as partial least squares (PLS) SEM mainly for two reasons. First, CB-SEM is more powerful in model validation since it can calculate the overall fit of a proposed model by comparing the proposed and observed covariance matrices (Hair et al., 2006; Lowry & Gaskin, 2014). Second, CB-SEM is more effective in validating models developed using a well-established theory. As our research model is deeply rooted in the SRR framework, we deemed CB-SEM to be appropriate (Lowry & Gaskin, 2014).

To ensure that the results of structural relationship were produced from a set of measurement instruments within the desirable psychometric properties, we first conducted the data validation with four analyses: (1) to support required convergent and discriminant validity, (2) to establish strong reliabilities, (3) to demonstrate multicollinearity as not a big issue for each measure, and (4) to check common method bias.

5.1 Measurement Model

Per the CB-SEM standards literature (Hong et al., 2013), the model fit was good: χ^2 436 = 1163.144; χ^2/df = 2.67; CFI= 0.913; TLI = 0.901; RMSEA = 0.067; SRMR = 0.067; CD = 1.000. The convergent validity was supported by large and standardized loadings for all constructs ($p < 0.001$) and *t*-values that exceeded statistical significance. Convergent validity was also supported by calculating the ratio of factor loadings to their respective standard errors that exceeded 10.0 ($p < 0.001$) (Hair et al., 2006; Lowry & Gaskin, 2014). Cronbach's alpha and summary statistics for our constructs are shown in Table D1 in the Appendix D.

Discriminant validity was exhibited when the average variance extracted (AVE) value of a latent construct was larger than its squared correlation with any other latent construct in the model (as shown in Appendix D Table D2). The test also showed that the measurement model had a significantly better model fit than a competing model with a single latent construct and was better than all other competing models in which pairs of latent constructs were joined (Marsh & Hocevar, 1985). In summary, these tests confirmed convergent and discriminant validities.

Given that most of our data are based on self-reported survey data, common method bias (CMB) was determined to be a potential issue influencing the data analysis. Therefore, we primarily examined CMB in the current study by using two kinds of approaches (as shown in Appendix D1). The results indicate that CMB is not a serious problem in the model.

The concern on multicollinearity arises because the correlations of the constructs exceed the criteria of 0.60 (Grewal, Cote, & Baumgartner, 2004). Given that the correlations of independent variables are higher than 0.60, we performed the variance inflation factors (VIF) of all independent variables by following the procedures proposed by Mason and Perreault (1991). The results indicate that VIF values in the current study range from 1.52 to 3.14 with an overall mean for the VIF scores of 2.05, below the generally accepted threshold of 3.3, demonstrating that multicollinearity is not a major issue for the model or dataset in this study.

5.2 Structural Model

After assessing the measurement model, we employed a maximum likelihood estimation to test the proposed relationship. Table 1 summarizes the model testing results, providing support for all predicted relationships in the model. Standardized coefficients and their significance are illustrated for each hypothesis. Taken as a whole, a significant amount (77.8%) of variation is explained by the SRR framework.

The results reveal a set of interesting findings. Specifically, the results show that urge positively impacts compulsive use of mobile SNS (β = 0.746, p = 0.000, H1 was supported), suggesting that felt urges could be a critical factor that substantially leads to compulsive behavior. This finding is consistent with previous studies that highlight the key role of the irresistible urge in the development of compulsive behavior (LaRose et al., 2003; Zheng & Lee, 2016).

In terms of the positive reinforcements, the results indicate that felt urges are positively associated with individuals' positive affect (β = 0.285, p = 0.002, H2 was supported), which is further influenced by gratification (β = 0.780, p = 0.000, H3 was supported). Previous studies have consistently recognized that mobile social networks are used to "strengthen the pleasurable and emotional experience" (Wang, Jin, et al., 2015, p. 183). Thus, we can draw the conclusion that enthusiastic psychological states in mobile SNS use positively influence the development of compulsive behavior.

Table 1. Summary of Model Test Results

Hypothesis/Relationship	β	*SE*	Z	P	Low CI	High CI
H1. URG → CU	0.746	0.076	9.75	0.000	0.596	0.896
H2. PA → URG	0.285	0.093	3.06	0.002	0.102	0.468
H3. GRA → PA	0.780	0.104	7.49	0.000	0.576	0.984
H4. NA → URG	0.298	0.048	6.19	0.000	0.204	0.392
H5. WIT → NA	0.825	0.052	15.82	0.000	0.723	0.928
H6. ER → URG	0.298	0.059	5.03	0.000	0.182	0.417
H7. INT →CU	0.147	0.059	2.50	0.012	0.032	0.262
H8a. INT → GRA	0.666	0.069	9.69	0.000	0.531	0.800
H8b. INT → WIT	0.442	0.083	5.32	0.000	0.279	0.604
H8c. INT → ER	0.734	0.080	9.16	0.000	0.577	0.891
Control variables						
Age → CU	-0.109	0.058	-1.87	0.061	-0.224	0.005
Gender → CU	0.103	0.085	1.22	0.223	-0.063	0.270
Education → CU	0.002	0.062	0.03	0.972	-0.120	0.124
Income → CU	-0.012	0.037	-0.32	0.753	-0.084	0.061
Employment → CU	-0.127	0.071	-1.80	0.072	-0.266	0.014
Usage experience → CU	0.049	0.042	1.18	0.240	-0.033	0.132
Notes: Model fit: χ^2: 1316.647 (df = 622); RMSEA: 0.055; CFI: 0.918; TLI: 0.909; SRMR: 0.080; CD: 0.900. R^2's: GRA = 0.335, PA = 0.019, WIT = 0.093, NA = 0.607, ER = 0.264, URG = 0.466, CU = 0.778.						

Table 2. Mediating Effect Test

Relationship	Direct effect without mediator	Direct effect with mediator	Mediation effect
PA→URG→CU	0.487 (0.000)	0.316 (0.000)	Partial mediation
NA→URG→CU	0.271 (0.000)	0.109 (0.002)	Partial mediation
ER→URG→CU	0.104 (0.035)	-0.059 (0.151)	Full mediation

The negative reinforcements were also found to be important in predicting the urge to use mobile SNSs. Specifically, withdrawal was found to significantly influence negative affect (β = 0.825, p = 0.000, H5 was supported), which in turn positively impacts felt urges (β = 0.298, p = 0.000, H4 was supported). Furthermore, the results also suggest that emotional relief has a positive effect on urge (β = 0.298, p = 0.000, H6 was supported), supporting the compensation tendency associated with compulsive behavior (American Psychiatric Association, 2000).

As expected, we found that interactivity has a significant effect on compulsive behavior (β = 0.147, p = 0.012, H7 was supported). The results also indicate that interactivity is positively associated with gratification (β = 0.666, p = 0.000, H8a was supported), withdrawal (β = 0.442, p = 0.000, H8b was supported), and emotional relief (β = 0.734, p = 0.000, H8c was supported), demonstrating that IT stimuli play a determinant role in the development of compulsive smartphone use. That is, in the presence of a high level of interactivity, individuals are more vulnerable to performing compulsive use of mobile SNSs, even without the feeling of urge and bypassing psychological reinforcements.

As for the controlled variables, the results unexpectedly indicated that age, gender, education, income, employment, and usage experience had no significant effect on individuals' compulsive use of mobile SNSs, providing findings contrary to previous addiction literature (Chou, Condron, & Belland, 2005). One possible explanation of these findings is that, in contrast to online gaming or gambling, for example, mobile SNS use is unique in that it is used specifically to pursue and maximize social interaction and obtain information (Malinen & Ojala, 2012; Park & Lee, 2011). Therefore, it is not surprising to find that mobile SNS appeals to users indiscriminately because social connection and obtaining information are widespread and general human desires; thus, one can assume that any user is potentially vulnerable to compulsive mobile SNS use.

Furthermore, we use Baron and Kenny's method to test the potential mediating effects of urge in the relationship between reinforcements and compulsive behavior (Baron & Kenny, 1986). As summarized in Table 2, urge partially mediates the effect of positive and negative affect, and fully mediates the effect of emotional relief, on compulsive mobile SNS use.

6 Discussions

6.1 Theoretical Implications

Although compulsive smartphone use has drawn considerable social attention for its serious outcomes, relevant theory-based studies are rare. To address this research gap, the current study adds new understanding of the underlying mechanisms and enacting variables associated with compulsive smartphone use. To adapt the SRR framework to the current context, the results of this study provide rich insights into how positive and negative reinforcements and compensation mechanisms impact compulsive mobile SNS use.

First and foremost, we advance our understanding of compulsive behavior by conceptualizing compulsive smartphone use, and mobile SNS in particular. Through distinguishing "compulsive behavior," "addiction," and "habit," we add conceptual clarity to compulsive use relative to its few adjacent concepts. We then propose a concise definition focusing on the behavior itself and define compulsive behavior as a single dimension rather than a multidimensional construct with its antecedents and consequences. We believe such conceptualization appropriate for providing a pivotal starting point and theoretical framing to capture the underlying mechanism of compulsive use (Meerkerk et al., 2010).

Second, we identify the unique characteristics and underlying mechanisms of the compulsive use of mobile SNS. Extant research has pervasively investigated compulsive behavior on the basis of compensation mechanisms (American Psychiatric Association, 2000; Neuner et al., 2005). By contrast, from the perspective of rational addiction, we propose that compulsive mobile SNS use tends to be voluntarily and rationally performed in the pursuit of rewarding experiences and that it is strengthened and becomes almost compulsory for users because of their desire to avoid feelings of missing out, anxiety, and withdrawal (Wang et al., 2014). Following this line of reasoning, we postulated that, in addition to the important role of emotional relief, the pursuit for rewards and the avoidance of punishment experiences also influences the development of compulsive mobile SNS use. Based on an extended SRR framework, we

further contribute to specifying the positive and negative reinforcements relevant to the mobile context and empirically test their impacts on compulsive mobile SNS use (Achab et al., 2011).

Third, we contribute to illuminating the pivotal role of urge in the development of compulsive use of mobile SNS. Although previous studies have widely recognized obtrusive thoughts or obsession in the context of compulsive behavior, they are limited in conceptualizing and theorizing their roles. Given that compulsive behavior acts as an impulse-control disorder, research suggests that the spontaneous and irresistible state could be reflected by the feeling of urge, which typically precedes the actual action. When experiencing strong urges, people become more vulnerable to repetitively engaging in checking behavior. The mediating effects tests we conducted also indicate that urge fully mediates the effect of emotional relief, and partially mediates the effect of positive and negative affect, on compulsive mobile SNS use. Hence, it can be concluded that urge plays a critical role in motivating compulsive behavior, which could be further identified and examined in future studies (Raylu & Oei, 2004).

Finally, the empirical test enhances extant research by clarifying the important role of technological attributes (interactivity in particular) in the development of compulsive behavior. Despite the wide recognition that the progress of information communication and technologies can facilitate problematic behavior (Strack, Werth, & Deutsch, 2006), the understanding of how technological factors facilitate compulsive behavior is quite preliminary. A more holistic understanding of how and why technology promotes compulsive behavior is warranted. Compared with the Internet and other technologies, the immediacy and continuous presence of smartphones allow users to behave more impulsively (Billieux, 2012; Malinen & Ojala, 2012). These technological facilitators strengthen the link between reinforcement and response, facilitating the development of a cycle of responsiveness (Perlow, 2012) rather than long-term learning processes (Akers et al., 1979) among users. On this basis, compulsive mobile SNS use is more likely to be mediated by the progressive loss of intentional control, accompanied by a transition to automatic control with associated stimuli (Hogarth & Chase, 2011). Therefore, as the checking behavior related to mobile SNSs is repeated, the link between the stimulus and response is strengthened, thus facilitating the development of compulsive smartphone use (Wang et al., 2014).

As such, it is important to identify more relevant technological factors to understand and predict compulsive smartphone use. Our paper contributes by identifying how technological attributes (e.g., interactivity) enable compulsive behavior as a kind of incentive stimulus, a focus that our literature review revealed to be lacking. This is consistent with the sociotechnical perspective that emphasizes the salience of social and the technical aspects in investigating a phenomenon. Although it is still in the initial stages, we hope that this research has made some headway in understanding the critical effect of technological facilitators on compulsive behavior.

6.2 Practical Implications

The results of this research also yield important practical contributions. Although compulsive smartphone use seems to be a "harmless usage habit," it has been associated with harmful and disturbing outcomes among individuals and in society at large (Billieux, 2012). Our empirical investigation is timely and enhances our understanding of the underlying process and motivators associated with compulsive smartphone use. Our results can help people capture, predict, and understand the processes involved in the development of compulsive smartphone use.

Specifically, the results indicate the need for systematic management of compulsive smartphone use, and mobile SNS use in particular, in schools, universities, and workplaces. Although mobile SNSs are pervasively used in daily life for social interaction and obtaining information, it should be noted that compulsive behavior is significantly different from habit. The former tends to be consistently uncontrolled in a way that may result in negative outcomes, whereas the latter is merely a routine behavior implemented to improve efficiency. From this perspective, individuals should be discouraged from the frequent and ritualistic mobile SNS use in the workplace (e.g., Facebook and WeChat) because users may become compulsive through repetitive usage, in spite of primary pursuits aimed at rational utility. Instead, we suggest that employers institute professional and formal communication channels for workplace communication as one means of counteracting the risk of promoting compulsive mobile SNS use among employees (e.g., Dingding as a mobile office platform in China).

This study also highlights the need for individuals to moderate their own behaviors based on recognition of the emotional reinforcements and the felt urge associated with mobile SNS use. Results of this study provide effective guidelines for individuals to manage their behaviors to alleviate the compulsive use of mobile SNS, such as regulating the felt urge, controlling the usage frequency, avoiding the emotion bias, and seeking help when feeling down.

Furthermore, the findings of this study suggest that service providers and managers of mobile SNS might develop effective strategies in reducing users' compulsive behavior. Although more research is

required, we believe that several strategies can be implemented. For example, creating an adjustable notification system in mobile SNSs might be helpful to reduce the compulsive behavior because users would be able to set up preferences for interactivity (e.g., when and where to chat, parameters concerning comments, likes, and share, etc.). Moreover, controlling the use of SNSs in designated spaces (e.g., in universities/workplaces) could be effective strategies to thwart compulsive behavior in the use of mobile SNS.

6.3 Limitations and Future Work

Despite the useful insights provided in this study, it still has some limitations. First, what, precisely, defines and constitutes compulsive behavior has not been addressed. This is mainly because compulsive use of mobile SNS tends to be more pervasive and socially useful in comparison with compulsive gambling, shopping, and general Internet use (Wang et al., 2014). Anecdotal evidence has also indicated that most users of mobile SNSs recognize themselves as having "Weibo Kong," "WeChat Compulsion," or "Facebook Addiction." Accordingly, we believe that clarifying the difference between compulsive and noncompulsive behavior is not necessary. Rather, it is assumed that each user is conceived as potentially vulnerable to a compulsive disorder, albeit to varying extents. Echoing this point, Meerkerk, et al. (2010) have recognized that compulsive Internet use should not be considered "an all or nothing phenomenon," because a clear definition with a distinct cut-off point is always arbitrary to some degree. Second, cross-sectional data cannot demonstrate a causal relationship based on the use of an empirical test. A longitudinal study is needed to further develop and test the proposed model. Third, our study only examined the antecedents of compulsive mobile SNS use. Future research on the consequential outcomes of compulsive behavior would provide further insights. Finally, it is noteworthy that we merely investigate interactivity as one kind of incentive stimulus leading to compulsive mobile SNS use. A thorough explanation of the underlying mechanism of IT facilitators in influencing users' compulsive behavior is not addressed in the current study and should be investigated in future research.

7 Conclusion

Whereas most extant literature on compulsive smartphone use focuses on exploratory studies based on the compensation mechanism, our study may be the first to integrate the stimuli-response-reinforcement mechanism in developing an understanding of compulsive mobile SNS use. Following the SRR paradigm, we propose a new theoretical model that was designed to understand and capture the underlying mechanism and enacting variables of compulsive behavior. We found the model to be largely supported, implying that the reinforcement process and compensation mechanism generally holds for explaining individuals' compulsive behavior in the context of smartphone use, and mobile SNS use in particular. Our findings expand the literature by emphasizing the roles of urge and interactivity that foster compulsive mobile SNS use.

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Appendix A. Conceptualization

Table A1. The Comparison among "Compulsive Behavior," "Addiction Behavior," and "Habit"

Nomenclature	Compulsive Behavior (C)	Addiction Behavior (A)	Habit (H)	Note
Definition	A repetitive, ritualistic behavior that a person performs without the ability to control, reduce, or stop (Caplan, 2002)	A psychological state of maladaptive dependency to such a degree with the typical behavioral addiction symptoms: salience, withdrawal, conflict, relapse and reinstatement, tolerance, and mood modification (Turel, Serenko, & Giles, 2011)	Learned sequences of acts that become automatic responses to specific situations, which may be functional in obtaining certain goals or end states (Verplanken, Aarts, & van Knippenberg, 1997, p. 540)	C vs. A: Compulsive behavior focuses on the uncontrolled behavior, whereas addiction emphasizes more on the psychological state. C vs. H: Compulsive behavior is more uncontrolled than habit. The latter just aims to obtain certain goals in a more efficient way, whereas the former is performed without control.
Characteristics	Stereotyped, effortless, stimulus-orientation, and uncontrolled (Tiffany & Carter, 1998)	Recurrent failure to control the behavior (powerlessness) and continuation of the behavior despite significant negative consequences (unmanageability) (Goodman, 1990, p. 1404)	Effortless, nonreflective, efficient, and routinized in certain situations (Lindbladh & Lyttkens, 2002)	C vs. A: Compulsive behavior is periodic repetition with stimulus-orientation, whereas addiction is a continuing pattern (Hooper & Zhou, 2007) or a continuum of unregulated behavior (LaRose, Lin, & Eastin, 2003, p. 233). C vs. H: Although both compulsive behavior and habit are engaged in effortlessly and nonreflectively, habit is only routinized in certain situations, whereas compulsive behavior is generally uncontrolled.
Internal drive	The need to alleviate tension, anxiety, or discomfort aroused by an obtrusive thought or obsession (American Psychiatric Association, 2000)	To produce physical or psychological pleasure or provide relief from internal discomfort (Goodman, 1990, p. 1404)	To lessen the required cognitive planning and conscious choice (Ortiz de Guinea & Markus, 2009)	C vs A: Compulsive behavior involves in an obtrusive thought or obsession about the specific behavior, whereas addiction does not pinpoint this point. C vs H: Compulsive behavior embraces internal alleviation of negative emotion, whereas the primary goal of habit is to be more efficient and effective.
Types of IT artifact	Compulsive Internet or smartphone use in general (Lee, Chang, Lin, & Cheng, 2014; Wang, Lee, & Hua, 2014; Zhang, Chen, Zhao, & Lee, 2014)	Specific addiction to an application is different from the generalized pathological use (Davis, 2001; Griffiths, 2012)	IS habit in general (Limayem, Hirt, & Cheung, 2007; Ortiz de Guinea & Markus, 2009)	C (H) vs. A: Addiction behavior studies have differentiated the general from specific usage, whereas compulsive behavior and habit research does not.
Research object	Shopping (Shoham & Brencic, 2003), using cocaine (Belin, Mar, Dalley, Robbins, & Everitt, 2008),	Gambling (Turel, Serenko, & Giles, 2011), email (Turel, Serenko, & Bontis, 2011; Turel & Serenko, 2010), game (Xu, Turel, & Yuan, 2011), social networking	System use (Limayem & Cheung, 2008; Limayem et al., 2007)	The same as the above.

	Internet (Meerkerk et al. 2010), smartphone (Wang et al., 2014)	(Wang, Lee, & Hua, 2015)		
Underlying mechanisms	Compensation (Neuner, Raab, & Reisch, 2005), punishment (Meerkerk et al., 2010; Wang et al., 2014)	Craving (Casey, 2012), rewarding experiences (Oulasvirta et al., 2012), impulsivity (Brewer & Potenza, 2008; Wu et al., 2013)	IS post-adoption and continuous use (Limayem & Cheung, 2008; Venkatesh, Thong, & Xu, 2012)	C (A) vs. H: The underlying mechanism of habit is totally different from compulsive and addiction behavior. It is noteworthy that addiction behavior discusses craving and impulsivity, whereas compulsive behavior involves compensation and punishment mechanisms.
Antecedents	Personality (self-esteem, loneliness, and depression) (Meerkerk et al., 2010), distorted needs/motives (Lee et al., 2014; Zhang et al., 2014)	Personality (deficient self-regulation) (Wang et al., 2015), cognitive-behavioral model (Davis, 2001; Turel, Serenko, & Giles, 2011)	Frequency of prior behavior, satisfaction, stable context, comprehensiveness of use (Limayem et al., 2007)	C (A) vs. H: The antecedents of habit have been well identified in previous studies. As for compulsive and addiction behavior, scholars have not reached the consensus on this issue. However, the role of personality has been recognized as influencing both behaviors, albeit with some differences.
Consequences	Debilitate or disrupt individuals' abilities to function, even become destructive if untreated (American Psychiatric Association, 2000)		Unregulated usage (LaRose et al., 2003), psychological dependence (Wang et al., 2015)	C (A): H: In comparison with habit, compulsive and addiction behavior should be paid more attention due to the potential negative consequences and related treatment.
Therapy and treatment	Need to seek evaluation from a medical or mental health professional who can recommend behavioral therapy, medication, and/or group-run recovery programs to help restore a sense of control over behavior			

Appendix B. Measurement Instruments for Research Constructs

Table B1. Measurement Instrument

Construct	Resources	No.	Items
Compulsive use of mobile SNS (CU)	(Meerkerk et al., 2010)	CU1	I often find it difficult to stop my mobile SNS use.
		CU2	I often continue to use mobile SNSs despite my intention to stop.
		CU3	I often think I should use mobile SNSs less often.
		CU4	I have often unsuccessfully tried to spend less time on mobile SNSs.
Urge (URG)	(Beatty & Elizabeth Ferrell, 1998)	URG1	I always experience a number of sudden urges to check my mobile SNS.
		URG2	I have not planned to check mobile SNSs when I am using my smartphone.
		URG3	I want to check my mobile SNS even though it is not part of my plan.
		URG4	I often feel a sudden urge to check my mobile SNS.
Gratification (GRA)	(Stafford, Stafford, & Schkade, 2004)	GRA1	I am gratified to instant chat with others on mobile SNSs.
		GRA2	I am gratified to instant connect with my friends on mobile SNSs.
		GRA3	I am gratified to share views and interact with other people in mobile SNSs.
		GRA4	I am gratified to meet new people on mobile SNSs.*
Positive affect (PA)	(Beatty & Elizabeth Ferrell, 1998)	PA1	While using the mobile SNS, I am excited.
		PA2	While using the mobile SNS, I am enthusiastic.
		PA3	While using the mobile SNS, I am happy.
		PA4	While using the mobile SNS, I am interested.
		PA5	While using the mobile SNS, I am joyful.
Emotional relief (ER)	(Caplan, 2002)	ER1	I have used mobile SNSs to talk with others when I felt isolated.
		ER2	I have gone to mobile SNSs to contact others when I was feeling isolated.
		ER3	I have used mobile SNSs to make myself feel better when I was down or anxious.
Withdrawal (WIT)	(Caplan, 2002)	WIT1	I become preoccupied with my mobile SNS if I can't use it for some time.
		WIT2	I would miss my mobile SNS if I couldn't use it.
		WIT3	When not using my mobile SNS, I wonder what is happening on it.
		WIT4	I feel lost if I can't use my mobile SNS.
		WIT5	It is hard to stop thinking about what is waiting for me on my mobile SNS.
Negative affect (NA)	(Beatty & Elizabeth Ferrell, 1998)	NA1	When I am not able to use the mobile SNS, I feel distressed.
		NA2	When I am not able to use the mobile SNS, I feel upset.
		NA3	When I am not able to use the mobile SNS, I feel irritable.
Interactivity (INT)	(McMillan & Hwang, 2002)	INT 1	Mobile SNSs enable two-way communication.
		INT 2	Mobile SNSs enable concurrent communication.
		INT 3	Mobile SNSs are interactive.
		INT 4	Mobile SNSs are interpersonal.
		INT 5	Mobile SNSs enable conversations.

Note: *Items were deleted due to the insufficient validity.

Appendix C. Demographics of the Respondents

Table C1. Demographics

Demographics	Count	Percentage (%)
Gender		
Male	230	62.50
Female	138	37.50
Age		
Below 18	1	0.27
18 – 25	186	50.54
26 – 30	142	38.59
31 – 40	24	6.52
41 – 50	10	2.72
51 or above	5	1.36
Education level		
High school or below	4	1.09
Vocational/technical school	30	8.15
Undergraduate degree	151	41.03
Postgraduate degree or higher	183	49.73
Employment status		
Full-time	143	38.86
Student	207	56.25
Unemployed	7	1.90
Other	11	2.99
Income		
Lower than 3000 Yuan	198	53.80
3000-4999 Yuan	61	16.58
5000-6999 Yuan	43	11.69
7000-8999 Yuan	25	6.79
Above 9000 Yuan	41	11.14
Experience		
Tenure as smartphone user		
< 6 months	3	0.81
6-12 months	18	4.89
1-2 years	66	17.93
2-4 years	169	45.93
> 4 years	112	30.44
Duration of everyday smartphone use		
< 1 hour	13	3.53
1-3 hours	106	28.81

3-5 hours	161	43.75
5-7 hours	57	15.49
> 7 hours	31	8.42
Tenure as mobile SNS user		
< 6 months	7	1.90
6-12 months	27	7.34
1-2 years	76	20.65
2-4 years	130	35.33
> 4 years	128	34.78
Mobile SNS usage frequency		
Several times a week	43	11.69
Once a day	40	10.87
Several times a day	154	41.85
Once an hour	60	16.30
Several times an hour	71	19.29

Appendix D. Summary Statistics of Constructs

Table D1. Summary Statistics

Construct	Cronbach's alpha	Mean	*SD*	VIF
Interactivity	0.8702	5.2625	0.0482	1.62
Gratification	0.7762	5.5326	0.0533	1.52
Positive affect	0.8663	4.8870	0.0487	1.97
Withdrawal	0.9170	3.6712	0.0737	3.14
Negative affect	0.9450	3.3207	0.0770	2.24
Emotional relief	0.8556	4.9284	0.0677	1.91
Urge	0.8470	4.3668	0.0692	1.98
Compulsive use of mobile SNS	0.8208	4.4022	0.0679	---

Table D2. Correlation Matrix and Square Root of the Average Variance Extracted for Constructs

Construct	INT	GRA	WIT	PA	NA	ER	URG	CU
INT	**0.776**							
GRA	0.335	**0.750**						
WIT	0.101	0.060	**0.831**					
PA	0.347	0.283	0.212	**0.775**				
NA	0.033	0.014	0.605	0.130	**0.919**			
ER	0.266	0.262	0.235	0.323	0.132	**0.836**		
URG	0.091	0.112	0.517	0.230	0.227	0.283	**0.769**	
CU	0.138	0.131	0.511	0.288	0.258	0.181	0.698	**0.735**

Common Method Bias

We used two kinds of approaches to examine common method bias in the current study. First, we used procedural remedies to invoke up-front research design to blunt common-method bias (Podsakoff et al., 2003). Such remedies include randomized items within the instrument so that participants would be less apt to detect underlying constructs, measures with different anchors, attention-trap questions, and reverse-coded items. We also provided extensive warnings and instructions to participants to maintain their focus on the survey.

Second, we tested the common method bias by using Harman's one-factor test. The results of the unrotated and rotated solution had six factors with eigen-values greater than 1, with the largest variance extracting 37.68% and 18.81%, respectively. No single factor dominated the majority of the variance. In addition, the most important problem with common method bias is high correlations among constructs. Hence, the correlation matrix of the data set was examined based on the procedure proposed by Pavlou et al. (2007). The correlation matrix (as shown in Appendix D2.) indicates that all correlations were significantly below the 0.90 threshold, which shows that common method bias is not likely to be a serious threat in the model.

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